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Issue Number 25

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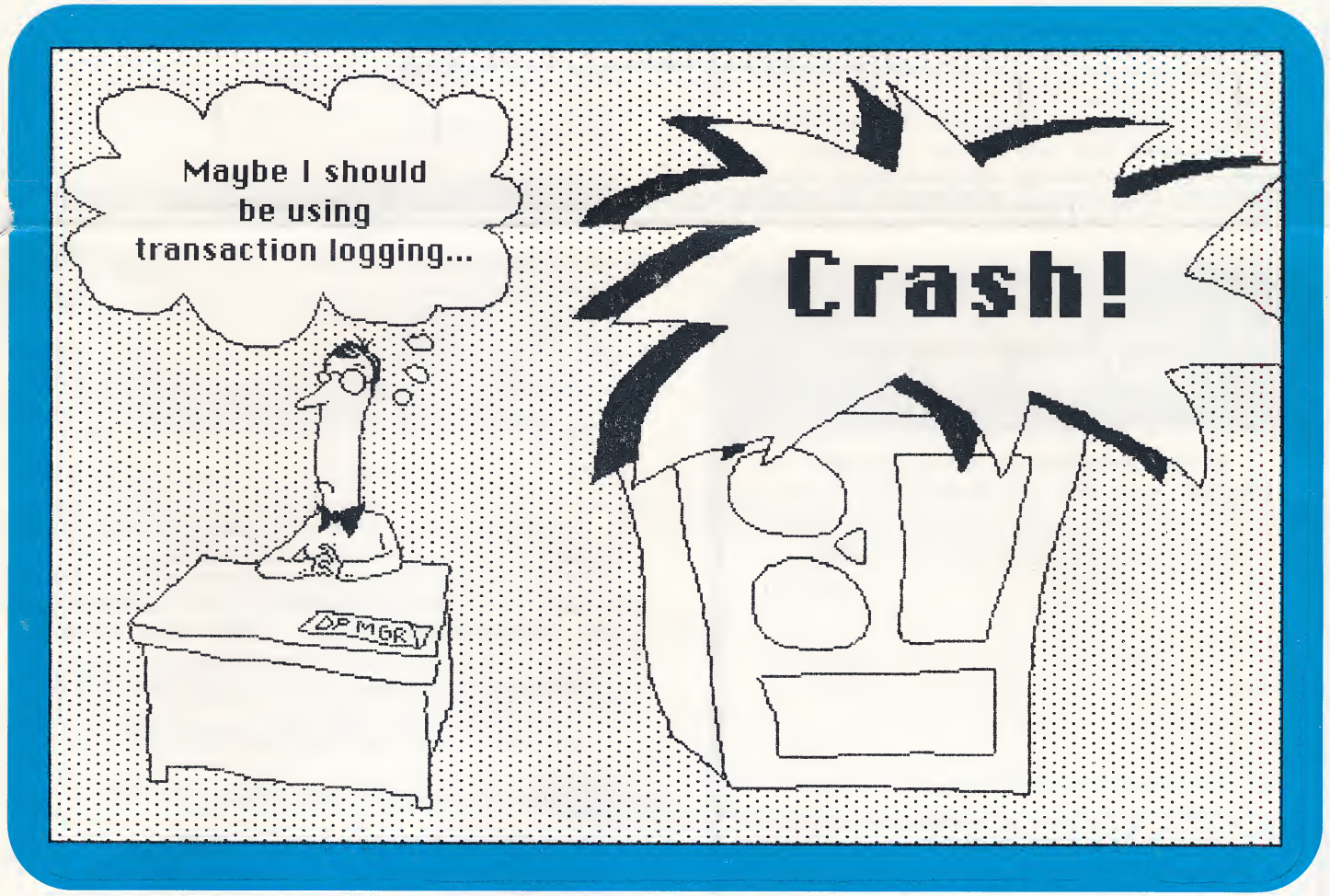

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Transaction Logging

Every data processing manager's worst fear is a crash—a crash that destroys files and corrupts data. In the worst case, a crash is so bad that the system must be completely reloaded from the last backup copy made of all files. When that happens, all work that was done on the system since that last copy was made is lost.

If backups are made only once a day, and the system has a dozen terminals, and each terminal is active half the time during one eight hour shift per day, then as much as 48 people-hours of work might be lost and forced to be redone if the system crashes and must be reloaded from the previous day's backup.

A good way to prevent having to retreat to a backup after a serious crash is to use a transaction log, which is a file that records every instance of any item being written or deleted in a file. If the system crashes, and if the transaction log can be recovered, the system can be brought back to the state it was in just before the crash occurred by first restoring the system using the last backup, then re-executing all transactions recorded in the transaction log.

For example, here's a simple application program that creates and deletes records in a customer file:

```
OPEN "CUST" TO CFILE ELSE STOP
LOOP
 CRT "CUSTOMER ID":
 INPUT ID
UNTIL ID="" DO
 READ CUST FROM CFILE, ID ELSE CUST=""
 CRT "OLD NAME & ADDRESS=":CUST
 CRT "NEW NAME & ADDRESS":
 INPUT NEW
 IF NEW # "" THEN CUST=NEW
 CRT "FILE OR DROP":
 INPUT COMMAND
 IF COMMAND="FILE" THEN WRITE CUST ON CFILE,ID
 IF COMMAND="DROP" THEN DELETE CFILE,ID
REPEAT
STOP
```

Imagine the above program being used all day to edit the customer file, while similar programs are simultaneously used for editing payroll, purchasing, inventory, and other files. If the system crashes, there's no possible way to easily determine what items were added or dropped to all those files since the last backup was made. (Note that even if each item is time-stamped every time it is written, there's still no evidence left to indicate what deletions took place.)

But imagine a small subprogram like the following:

```
SUBROUTINE LOGIT(LOG.FILE,TYPE,FILE,ID,ITEM)
LOOP
 L.ID=TYPE:"*":FILE:"*":ID:"*":DATE():"*":TIME()
 READU LOG FROM LOG.FILE,L.ID ELSE LOG=""
UNTIL LOG="" DO
 RELEASE LOG.FILE,L.ID
REPEAT
WRITE ITEM ON LOG.FILE,L.ID
RETURN
```

By calling the above LOGIT routine every time an item is

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written or deleted, the system can maintain a complete history of all transactions made. To use LOGIT, the customer file update program becomes:

```
OPEN "LOG" TO LFILE ELSE STOP
(SAME CODE AS BEFORE)
 INPUT NEW
 CRT "FILE OR DROP":
 INPUT COMMAND
 BREAK OFF
 IF COMMAND="FILE" THEN
  IF NEW # "" THEN CUST=NEW
  WRITE CUST ON CFILE,ID
  CALL LOGIT(LFILE,"F","CUST",ID,CUST)
  END
 IF COMMAND="DROP" THEN
  DELETE CFILE,ID
  CALL LOGIT(LFILE,"D","CUST",ID,CUST)
  END
 BREAK ON
(SAME CODE AS BEFORE)
```

Notice how the *original* CUST value (not the NEW last minute change by the operator) is passed to LOGIT when an item is deleted, so that the LOG file will have an accurate record of exactly what the old data was.

The LOG file should be cleared after each successful backup. Then, if all update programs are careful to call LOGIT every time an item is written or deleted, the LOG file will fill up with a complete profile of all activity since the last backup was made. If the system crashes so badly that it's necessary to restore the system from the last backup, first T-DUMP the LOG file to tape. (Even if a system is so badly damaged in a crash that it won't reboot, a good trick is to first reload a minimum system consisting of just the SYSPROG account with a tiny Master Dictionary containing only a handful of verbs and no files, so that as little as possible of the old system's files, especially LOG, are overwritten on disk. Then use the editor to manually create a D-pointer to the frames of the LOG file, using the base, modulo, and separation values from a recent file-save listing. Then T-DUMP the recovered LOG file, and finally restore the system using the last backup.)

After restoring the system from the last backup, T-LOAD the LOG file back onto disk, SSELECT its items chronologically using the date and time saved in each LOG item id, and feed the selected list to a "refiling" program like the following:

```
OPEN "LOG" TO LFILE ELSE STOP
100 READNEXT LOG.ID ELSE STOP
FNAME=FIELD(LOG.ID,"*",2)
OPEN FNAME ELSE STOP "CAN'T OPEN ":FNAME
ID=FIELD(LOG.ID,"*",3)
TYPE=FIELD(LOG.ID,"*",1)
BEGIN CASE
CASE TYPE="F"
 READ LOG FROM LFILE,LOG.ID ELSE STOP
 WRITE LOG ON ID
CASE TYPE="D"
 DELETE ID
CASE 1 ; STOP "BAD LOG TYPE"
END CASE
DELETE LFILE,LOG.ID
GO TO 100
```

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The refiling program repeats all the work done on the system since the last backup, thereby bringing all files back to the state they were in just before the crash occurred.

Note that the LOG item identifiers are constructed in a way that assumes file names are unique throughout a system, even between accounts. If your system uses the same file name in different accounts, account names must be included in LOG item identifiers (and the refiling program changed accordingly), so that transaction items for one file can never be confused for another file. Also, using a one-second-resolution TIME function for building identifiers means that LOGIT prohibits updates to the same file item more than once per second.

Also be sure that long file and item names don't cause a LOG identifier to be longer than the system limit, which is typically 50 characters. Note also that deletions technically don't have to save any item data in the LOG file, since the LOG id itself has enough information to allow the refiling program to re-enact the deletion. However, saving a LOG record for every delete (and assuming that records are never null) simplifies the LOOP test in LOGIT, since the presence of a record indicates a used id. Plus, to give an added level of confidence that refiling is proceeding correctly, the refiling program can be modified to confirm the data about to be deleted:

```
READ LOG FROM LFILE,LOG.ID ELSE STOP
BEGIN CASE
CASE TYPE="F"
 WRITE LOG ON ID
CASE TYPE="D"
 READ CURRENT FROM ID ELSE CURRENT=""
 IF LOG # CURRENT THEN STOP "MISMATCH!"
 DELETE ID
```

Ideally, the operating system itself should automatically maintain a transaction log, which would actually accumulate onto an always-mounted scratch tape to prevent possibly losing the history data along with the rest of the system when the inevitable crash finally occurs. But with a little effort, even a tape-based history can be accomplished right now on existing systems: update programs can fill a LOG file on disk as already described, while a separate process with a mounted tape periodically deletes the LOG items from disk and moves them to tape. Δ

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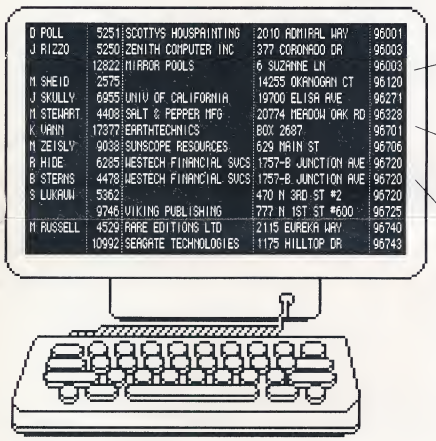

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